Center Innovation Fund: MSFC CIF

Long Term In-Space Cryogen Storage - Magnetic Isolation

Completed Technology Project (2012 - 2012)

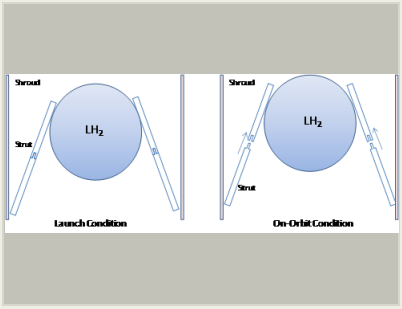
Project Introduction

A research activity is proposed to assess the feasibility of magnetic and/or quantum levitation techniques to hold cryogenic fluids in space for extended durations with a greatly reduced fluid boil-off rate.The proposed scheme would conductively isolate the tanks from warmer spacecraft structure in order to provide a robust thermal barrier.Heat leak through structural attachments may represent as much as half of the total energy absorbed by the storage volume in a typical application.

The innovation of this proposal is the use of magnets, either rare earth, electromagnetic or diamagnetic, to essentially act as a spring to open a thermal isolation gap in either a strut or direct structural attachment between a cryogenic storage vessel and the bounding vehicle shroud or sun-shade. The gap may remain closed under the influence of gravity but open once on-orbit or in-space. Powerful Neodymium magnets with repulsion/pull forces exceeding 1000 lbs for 4" diameter samples as well as recent developments in quantum levitation utilizing cryogenically cooled superconductors make a different type of isolation solution feasible, possibly with reduced launch mass or volume over existing strategies. Feasibility is based upon a significant reduction in heat leak (relative to conventional technologies) without a significant mass penalty. Current thermal isolation technology for on-orbit cryogenic storage is based primarily upon multi-layer surface insulation and low thermal conductance support straps. The proposed innovation addresses the shortcomings of current approaches by replacing low conductance straps/struts with a gap driven isolation scheme. Reducing or virtually eliminating the structural heat leak could have profound impacts for the scope and duration of future exploration and science missions. Ultra low thermal conductance cryogenic struts achieved through magnetic levitation could leverage MSFC involvement in any number of Dewar based science or cryogenic fuel depot projects. The objective of this activity is to develop a conceptual design of a magnetic levitation scheme to support and isolate a 2 meter diameter liquid hydrogen cryogenic propellant storage tank in a representative on-orbit or in-space environment. It is anticipated that a design study will advance the TRL 1 concept (i.e. never demonstrated) to TRL 2 with a strong basis for future advancement to TRL 3 or 4.

Anticipated Benefits

The innovation should further enable future exploration and science missions dependent upon long term cryogen storage.



Project Image Long Term In-Space Cryogen Storage - Magnetic Isolation

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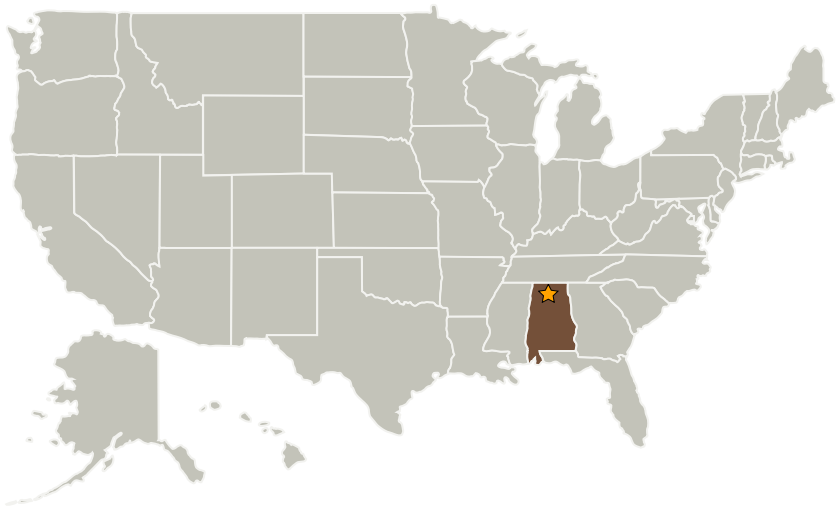
Long Term In-Space Cryogen Storage - Magnetic Isolation

Completed Technology Project (2012 - 2012)

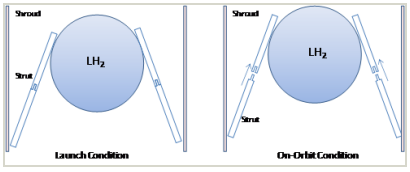
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations
Alabama

Images



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Project Image Long Term In-Space Cryogen Storage - Magnetic Isolation
(https://techport.nasa.gov/image/1326)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Center / Facility:
Marshall Space Flight Center (MSFC)

Responsible Program:
Center Innovation Fund: MSFC CIF

Project Management

Program Director:
Michael R Lapointe

Program Manager:
John W Dankanich

Project Manager:
Richard G Schunk

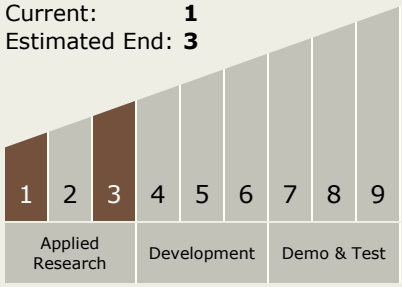
Principal Investigator:
Richard G Schunk

Long Term In-Space Cryogen Storage - Magnetic Isolation

Completed Technology Project (2012 - 2012)

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.1 In-space Propellant Storage & Utilization